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Sensing carbon allotropes in protective coatings on optical fibers with far- and near-field Raman spectroscopy and microscopy

Kharintsev S., Saparina S., Stolov A., Li J., Fishman A.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

Copyright © 2017 John Wiley & Sons, Ltd. Hermetic carbon coatings of different thicknesses ranging from 1 to 100 nm on a series of optical fibers are characterized with confocal Raman spectroscopy and atomic force microscopy. Standard far-field Raman spectra in the region of 1,000–2,000 cm −1 were fitted and well reproduced using 5 individual components assigned to different species of graphite-like and disordered phases. Based on the fitting, a new spectroscopic indicator was proposed: √G * D * /Δ, where G * and D * and Δ are intensities at the maxima of the graphite-like G peak and the disorder-induced D peak and the dip between them, respectively. This indicator provides a measure of soot fraction in carbonaceous materials. A tip-enhanced Raman scattering (TERS) technique confirmed the complex structure of the first-order Raman D band assigned to disordered graphitic lattice vibrations. In addition, the TERS method provided convincing evidence for the formation of carbon allotropes, such as carbon nanotubes in the coatings. Possible effects of allotropes on hydrogen and water permeation through carbon coating are discussed in the view of the obtained results.

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Keywords

carbon allotropes, hermetic coating, optical antenna, optical fiber, tip-enhanced Raman scattering

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